PROGRESS REPORTS
FROM
EXPERIMENT STATIONS

SEASON 1953-54

NORTHERN NIGERIA

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NORTHERN NIGERIA

PROGRESS REPORT FOR THE SEASON 1953-54

Planting Period: June to August.
Picking Period: November to February.
Close Season: April to June.
Rainfall at Samaru, May to October 1953: 45·56 inches.
Rainfall Average, 1924-1953 : 43·73 inches.

General Introduction.

BY

H. E. KING

Season.

The season was a good one. Rainfall over most of the cotton growing areas was such that food crop planting was completed in time for cotton to be sown nearer the optimum date than usual. Hence, although late rains were not exceptionally good, and indeed poor in some areas, the bulk of the crop gave a fair yield. Picking was much earlier than in some recent seasons.

With a total issue of seed for planting of 13,588 tons, and an average return of close on ten bales of ginned lint per ton of seed, the export crop of Allen reached 135,683 bales of 400 lb. The whole of the seed issue for the Allen area was in fact strain Samaru 26C. Without the higher yield and ginning percentage of this strain, the crop would have been smaller by perhaps 20,000 bales.

In addition to this 26C crop, the area growing "Benue Ungraded", ginned at Lokoja, gave a good crop for the second year running, reaching 5,119 bales and making the grand total for Northern Nigeria 140,802 bales.

At Samaru the weather was on the whole reasonably good. Insect pests are dealt with in detail in a later section. They were not unduly heavy in general but mirid damage interfered seriously with some yield tests.

Bacterial blight (*Xanthomonas malvacearum*) was widespread and in places quite heavy; a section of this report is devoted to a discussion of the status of the disease in Northern Nigeria.

At Daudawa yields in the various stages of the seed multiplication scheme were generally good, but mirid damage was extremely heavy on one area of well-grown Stage C cotton and appeared responsible for what was a most disappointing yield.

At Gombe extremely good yields were obtained in the area issued with the pure 26C seed for multiplication. The total production, representing a seed increase rate approaching 1: 8, would have sufficed to supply all the requirements of Gombe division for 1954-55 but, most unfortunately, nearly half the produce was grade three. This matter is discussed in a later section.

Staff, Buildings and Land.

Mr. King was absent on leave in England from 9th July to 18th September 1953. Mr. Choyce proceeded on leave on 29th March, 1954. Mr. A. M. Krzywon took leave from 19th May to 24th September, 1953. Mr. D. A. Lawes arrived in Nigeria to assist with the plant breeding at Samaru on 9th September, 1953.

Mr. R. L. Burgess, of Messrs. Plant Protection Ltd., England, carried out investigations at Samaru and Daudawa in association with the staff of the Corporation and of the Department of Agriculture during the period from 4th June to 25th November, 1953. His work on seed disinfection is referred to in a later section. Dr. G. M. Wickens, Senior Plant Pathologist of the Corporation, paid a visit to Northern Nigeria in late November 1953 to study the incidence of bacterial blight and advise on future work here.

A number of additional African Agricultural Assistants, newly released from the training school, joined the staff at the beginning of the season but these welcome additions must now be set off against the loss of three older experienced men leaving the work to take up scholarships.

In co-operation with the Botanist and the Engineering Branch, a further 20 acres of land was cleared for cropping. An additional store for seed cotton was taken over and an open shed built for use in seed treatment.

Plant Breeding.

BY

H. E. KING

The work has continued to consist predominantly of straight reselection and testing of material derived from Samaru 26C and its relatives. A number of introduced types have however been kept under observation as possible alternatives to 26C or as potential parents in a hybridization programme. Co-operation in trials of Egyptian type cotton (*G. barbadense*) in Niger Province and elsewhere has been maintained.

Replicated Progeny Row Tests.

A test containing 48 progenies and a control type was planted in a balanced incomplete block design with 8 replications. Yields were high and significant differences occurred between progenies in seed cotton yield. In addition wide differences were found in ginning percentage and lint length as well as in such field characters as jassid resistance.

A number of very promising progenies have been picked out to go forward to larger scale trials.

Small Bulks Test.

This test also contained 49 treatments with 8 replications. In this case, small bulks (the next stage beyond progenies) were tested against 26C controls. The material under trial included a number of reselections from Samaru 26C and some from the related strains 26G, 26H and 26I. There were also a few other derivatives of Allen including some bred from D5, from which Samaru 26C arose.

Differences between treatments were very highly significant and, taking into account ginning percentages and lint lengths, it was possible to choose with considerable confidence thirteen strains worthy of further testing. These included some 26I and D5 derivatives.

Six of the types in this test appeared twice, once using self-bred seed and once natural (open pollinated) seed. There appeared to be no difference in yielding power—no hybrid vigour was shown by plants from natural seed. The mean yields for the six types were as follows: —

Self-bred seed	896	lb. per acre
Natural seed	882	lb. per acre
Standard error	± 18·5	lb. per acre

Strains Test.

Promising material brought forward from the previous season's small bulks test, together with strains already under trial and a number of control types, made up a set of 49 treatments for a third balanced incomplete block design with eight replications. Eight of these treatments were strains also included in the district variety tests (see later) while many of the others were relatives and rivals of these, excluded from the district tests in making the choice to fill the eight places available.

The plot size for this experiment was approx. 1/200th acre (against approx. 1/400th for small bulks test and 1/800th for replicated progeny row test). A moderately low standard error was obtained and differences between treatments were very highly significant. The experiment was not however a satisfactory one as vegetative growth was too strong and damage by mirids very heavy. In consequence, botanical observations on the plants were vitiated and the yield differences cannot be taken to represent the relative merit of the strains under other (more normal) conditions.

It was possible, however, taking into account the results of this test, the small bulks test and the behaviour of some of the strains in previous seasons, to choose 4 new candidates for the coming season's district variety tests. Amongst these are two relatives of strain 479-25

(see later) of great promise, and a derivative of 26I combining high seed cotton yield with high ginning percentage.

The performance of the 8 strains included here as well as in the district variety tests was, in general, in keeping with the results of the latter. The new issue however did better in this test in comparison with nucleus stock. Strain 49160-23 was disappointing; notably early, it was overtaken by other strains in late pickings. MU8 gave its usual performance, an increase of about 25% over 26C in seed cotton yield with the advantage in terms of lint reduced to 17% by reason of its low ginning percentage. This fruitfulness was manifested in spite of symptoms of bacterial blight (angular leaf spot and vein lesions) which singled it out as clearly more susceptible than 26C. It maintained its previous record of relative freedom from leaf tattering ascribed to mirids.

Included in this test were two bulks both representing the select progeny bulk made up from 10 progenies and tested last season. Seed was taken from a multiplication plot of this bulk and, in addition, a new lot was prepared by mixing afresh seed of the 10 components, each from its own separate multiplication plot of 1952-53. The 10 components also appeared in the test as separate treatments. The yields of seed cotton in lb. per acre were: —

Once grown bulk	...	...	...	647·3 ± 27·4
Fresh bulking	...	...	...	646·8 ± 27·4
Mean of 10 components		...	...	657·2 ± 8·7

There is no evidence here of any gain from mixing related material and allowing cross pollination in it for one season.

District Variety Tests.

The number of sites at which these tests were carried out was increased by one, making nine, and at three of them the experiments were duplicated to cover timely and delayed planting. Of the total of twelve experiments one was a complete failure (Maigana) through very bad growing conditions and one (the delayed planting at Samaru) a failure statistically through very high soil heterogeneity.

The two experiments at Gombe could not be planted until August, as the seed was mislaid on the way.

The remainder were very successfully carried out (except for some mishaps with the picking) and gave useful, and on the whole consistent results. The experiments in the present main producing areas, from Sokoto (represented by Gusau) to Gombe, all gave average yields falling within the range 420-650 lb. seed cotton per acre and reasonably comparable standard errors (see Table 1). These, therefore, have been taken together for presentation of combined results in Table 2.

TABLE 1.

DISTRICT VARIETY TESTS. SEASON 1953-54.

SEED COTTON YIELDS FROM TEN EXPERIMENTS.

Locality, with yield of control type in lb. per acre in brackets.	*Yields of other strains as percentage of the control type. (26C commercial stock ex Stage F).*							*S.E.*
	Nucleus Stock	*New Issue*	49160 -23	479 -25	479 -27	49197 *BCP*	4721 -65	
Samaru (422)	109	109	107	117	112	115	108	6·3
Daudawa (timely) (647)	106	100	99	112	92	96	93	4·9
Daudawa (delayed) (442)	104	103	98	117	94	108	94	7·1
Gusau (511)	102	105	104	107	111	102	104	4·2
Gombe (timely) (609)	105	100	105	108	99	99	100	3·7
Gombe (delayed) (407)	101	96	108	109	104	102	108	6·6
Kano (478)	102	101	94	101	92	114	109	5·2
Maiduguri (797)	104	106	107	94	100	112	114	5·1
Kontagora (128)	100	102	106	116	101	97	115	6·8
Zonkwa (214)	84	96	99	95	109	104	101	7·8

The produce of all these tests was received at Samaru for ginning and sampling so that it is possible to quote ginning percentages, calculated lint yields and lint lengths in presenting the results. This has been done in Table 2.

TABLE 2.

DISTRICT VARIETY TESTS, 1953-54.
DATA FROM SEVEN EXPERIMENTS COMBINED
(see footnote (a))

Strain	*Seed Cotton Yield (b)*	*Gin % (c)*	*Lint Yield (d)*	*Lint Length (e)*
Commercial stock (ex Stage F)	505 (100)	34·2	173 (100)	35·1
Nucleus stock (ex Stage C)	526 (104)	34·9	184 (106)	35·8
New issue (ex Samaru)	515 (102)	34·6	178 (103)	36·0
26C/49160-23	516 (102)	34·6	178 (103)	36·0
26C/479-25	556 (110)	33·3	185 (107)	36·2
26C/479-27	505 (100)	33·8	171 (99)	36·2
26C/49197 BCP	527 (104)	34·9	184 (106)	35·7
26C/4721-65	514 (102)	35·7	184 (106)	35·1

(a) Samaru, Daudawa (2), Gusau, Gombe (2), and Kano.

(b) Seed cotton yield given in lb. per acre, averaged over the seven experiments, and (in brackets) as percentage of commercial stock.

(c) Average for the seven experiments.

(d) Pounds per acre and as percentage of commercial stock.

(e) Halo length on the combed seed in millimetres, average of seven experiments.

It will be seen that these tests have provided confirmation that the nucleus stock of Samaru 26C (ex Stage C) is a small advance on commercial stock in seed cotton yield and has a higher ginning percentage and longer lint. It is the result of two seasons of multiplication at Daudawa of the issue made in 1951 of what was then described as new nucleus stock. This was produced by bulking the seed of 66 chosen progenies of 26C derivation grown at Samaru in season 1950-51 from single plant selections made in 1949-50 season.

The commercial stock included for comparison is second wave seed which has undergone five seasons of multiplication since its issue by the Botanist in 1948 and was at Stage F of the multiplication scheme in 1952-53. The earlier issue—first wave seed—was known to have deteriorated and was not included in these tests.

The stock described as new issue has given slightly poorer average figures than nucleus stock, chiefly due to poor results at Gombe, but has slightly longer lint.

Among the 26C substrains 479-25 stands out at Samaru, Daudawa and Kontagora and did well at Gusau and Gombe. This is the second season that it has given superior yields in these tests. It is of high lint quality, appreciably longer than 26C and in spinning tests giving distinctly stronger yarns. A mass reselection, expected to show an improved ginning percentage, is being multiplied at Samaru in 1954-55.

As demonstrated last season, 479-25 is also notably earlier in cropping than 26C. The delayed planting experiments were intended to test whether this character resulted in a greater increase in yield (relative to 26C) with a shorter growing season. Of this there was, however, no real indication this season, either with this strain or 49160-23, another early type. This latter did poorly this year compared with last and is being replaced in future tests by a mass reselection.

The strain 4721-65, with higher ginning percentage, is one of a series of promising selections some of which, now coming forward, are expected to prove better yielding and of greater lint length.

Of the experiments excluded from Table 2 (viz., the last three in Table 1) Maiduguri gave an unusually high average yield (for Nigeria). The order of merit of the strains was quite out of keeping with that shown elsewhere. Strain 479-25 was actually the lowest though the differences were not significant. This result is probably accidental, as the same strain at Maiduguri last season did well. However, conditions there are abnormal in that the low rainfall of the area seems to be supplemented, on the experiment farm, by abundant underground water.

In the Kontagora experiment, yields were once again very low, although in the district as a whole the cotton crop was much higher

yielding this season. Strain 479-25 did very well (relative to others), as last season.

Zonkwa, with very low yields and high standard error, provided no real information on the relative merit of the strains.

Seed Multiplication Plots.

All the strains under test were included also in multiplication plots. Yields in these were generally good though not up to the level of the previous season. Owing to shortage of labour and working cattle the preparation of the land was delayed. Early rains caused excessive weed growth, the removal of which prior to planting caused further delay and doubtless resulted also in the removal in quantity of plant nutrients. Fields manured early with farmyard manure grew a particularly heavy crop of weeds in June.

In addition to bulk seed production many of these plots were utilised for single plant reselection work. In several a very large number of plants were selected, described, and picked for laboratory tests. From these, after consideration of ginning percentages, lint lengths, seed weights and plant yields, bulks were made up in a manner similar to the modal bulk technique employed in Uganda.

The two most important of these were the plots of 479-25 and 49160-23 (see under district variety tests). From the former, 1,157 plants originally selected in the field were reduced by reselection in the laboratory to 515 giving 49 lb. of seed. From the latter 782 selections were reduced to 193 to give 27 lb. of bulk seed.

Certain plants were kept from these and other strains for planting as progeny rows.

Seed Multiplication Scheme, Gombe.

Sixty tons of seed of Samaru 26C from the Daudawa multiplication scheme were transported to Gombe and issued under close supervision to cultivators in the area served by the Pindiga cotton market.

The yields obtained were extremely high, the total weight of seed cotton purchased at Pindiga market being about 760 tons. This represents over 12½ tons of seed cotton per ton of seed issued. The nearest comparable figure, that for Stage E in Southern Katsina, was 10·9 and the average for the whole of Northern Nigeria about 5·2.

The British Cotton Growing Association co-operated in this scheme by agreeing to become sole buyers at Pindiga. The Administration assisted by declaring the area a seed multiplication area in which restrictions could be imposed on the movement of seed cotton.

Unfortunately the Pindiga cultivators, new to cotton growing for export, have no tradition of picking their seed cotton clean enough to be passed as grade 1. It was not on the whole probably any dirtier,

as picked, than that in other regions but was presented for grading with little or none of the trash and diseased and stained cotton removed. In consequence, it was graded about 50% grade 2 and 50% grade 3.

In general, seed obtained by ginning grade 3 seed cotton must be regarded as less suitable for planting than grades 1 and 2. On average it can be shown to contain more pink bollworm larvae and give a lower percentage germination. It may also be more heavily infected with bacterial blight.

It is, therefore, customary to reject grade 3 seed when arranging seed distribution for planting. The present state of affairs in Gombe Division suggests that action is required to make it clearly profitable to the cultivator to pick over his produce, as has been the general rule elsewhere. The alternative of accepting seed from grade 3 as fit for planting is an undesirable departure from a sound general rule.

The rejection of grade 3 seed from Stage C of the Daudawa scheme, in contrast, meant a loss of only 1·8% of the total seed produced. This produce is picked over in store by paid labour without regard to economics.

Studies of Bacterial Blight and Seed Disinfection.

BY

H. E. KING

The status of bacterial blight (*Xanthomonas malvacearum*) as a factor affecting yields in Northern Nigeria is not yet well defined. The apparent position over the last seven seasons is summarised below:

1947-48 (Hutchinson and Pearson). Disease present but, having regard to the standard of resistance of Samaru 26C, probably not very important.

1948-49 (Departmental Staff). Recorded, with some strain differences observed, but not noted as serious on 26C.

1949-50 (Cotton Breeder). Symptoms (angular leaf spot and vein blight) considered to be sufficiently extensive and severe to reduce yield of 26C. Strain differences marked, many imported types more susceptible.

1950-51 Much less in evidence, late in appearing. Strain differences not easily seen. Attempt to produce infection by spraying with inoculum unsuccessful.

1951-52 Again symptoms late in appearing and never reaching serious proportions. Importance of the disease as affecting 26C very much in doubt.

1952-53 Much more obvious, widespread and serious. Some 26C reselections of previous two seasons now found to lack adequate resistance.

1953-54 Again marked but possibly rather less so than in 1952-53. Clearly very variable indeed in its incidence from field to field.

Dr. G. M. Wickens, Senior Plant Pathologist of the Empire Cotton Growing Corporation, Uganda, who visited Northern Nigeria in November 1953, expressed the opinion that the general level of leaf infection was such as to be capable of reducing yield considerably. In addition, on some crops infection on sympodial branches was severe enough to cause appreciable direct loss to fruits.

It was further noted that damage was far more prevalent and severe where growth was poor as a result of poor soil, waterlogging and delayed weeding. Under better conditions the plants seemed able to tolerate a high degree of infestation by the pathogen and display strong stem resistance and some degree of leaf resistance.

The great variation in intensity of infestation and nature of symptoms makes it virtually impossible to suggest any figure for the loss of yield which may be caused by this disease, and also to design and carry out a trial to provide a sound figure for loss under natural conditions.

Evidence was, however, obtained from seed disinfection trials this season that a reduction in visible symptoms can, *in certain circumstances*, be followed by a marked increase in yield.

Mr. R. L. Burgess of Messrs. Plant Protection Ltd., laid down and supervised a number of replicated trials at Samaru and Daudawa using as seed dressings a number of chemical compounds known to reduce seed infection. In addition, some larger observation areas were planted in co-operation with the Senior Agricultural Officer, Daudawa.

Briefly, these trials showed that seed disinfection, particularly with organic mercuric compounds, could result in conspicuously less visible infection on seedlings and young plants and that this relative freedom from symptoms persisted for much of the season. The protection so afforded could be shown statistically to be associated with a quite marked yield increase in one experiment, and an apparent relationship was noted in certain of the observation areas.

In three other experiments obvious symptoms of disease failed to develop on the plants from untreated seed and no advantage whatever could be claimed for seed treatment.

It seems probable that the routine treatment of cotton seed for planting could have an appreciable effect on average, but that its value will be dependent on season and local conditions. In any

particular instance it may be that no improvement in yield can be demonstrated because conditions are unfavourable to the development of the disease or the untreated seed does not carry viable infection. The possibility of seed disinfection being rendered useless by infection coming in later from elsewhere has not yet been demonstrated in Northern Nigeria but must also be considered. Widespread use of disinfected seed over a number of years would perhaps reduce this danger.

On balance, the chances of seed disinfection proving economic seem good and continued trials are strongly indicated. The cost, with a battery of hand churns dressing a quantity of 37 tons, has been calculated as barely one shilling per acre. This requires an additional yield of seed cotton per acre of only three pounds to make the process profitable. There would, however, be some difficulty in organizing the mass disinfection of 15,000 tons of seed annually.

It is hoped that disinfection of the seed used in the earlier stages of the multiplication scheme may have an effect persisting into the areas receiving the produce therefrom and eliminate the need for dusting the later stages.

Agronomic and Fertilizer Experiments.

BY

H. E. KING

Problems met with in the course of the plant breeding work, as a result of incomplete knowledge of the physiological, agronomic and fertilizer requirements of the cotton crop, have been made the subject of experiments largely carried out by the Agronomist and Chemists of the Department of Agriculture working at Samaru.

As mentioned last season, a number of long-term rotation and manurial experiments are now beginning to yield figures of great interest but have not yet reached a point where detailed results can be given.

The data now accumulated from dates of sowing trials at Samaru, and a number of other stations, are now, however, sufficiently comprehensive to give firm guidance on the matter of optimum time of planting. The conclusions accepted locally are recorded in the following paragraphs.

The overall effect of varying the planting date over the range mid June to late August can be defined fairly clearly for average seasons and the main cotton growing areas. Between mid June and early July there is not, on average a great deal to choose in terms of gross return

per acre. June is sometimes substantially better and sometimes not. The variation can probably be accounted for by differences in June rainfall and the incidence of insect pests. With adequate soil moisture in mid June, and in the absence of crippling attack by bollworm and stainer, June planting would probably always be superior.

There are, however, four reasons for not advocating June planting as recommended by Geering and Baillie.* Firstly, without effective prohibition of August planting, the result would be a further spread of planting dates with consequently more favourable conditions for insect pests within the growing season. Secondly, it would reduce the length of the close season. Thirdly, it would in some seasons result in the first bolls opening before the end of the rains, with consequent loss of grade. Fourthly, it would invite the accusation that the interests of the cotton crop were being promoted at the expense of food crops. In many seasons it would not be possible with present farming systems to get the food crop planting completed in time to turn to cotton planting extensively in mid June.

The present policy is to tolerate planting in the second half of June where it is practised but to give the first week of July as the *recommended* date everywhere.

Beyond early July further delay in planting will almost always result in a marked drop. August planting will, on average, yield no more than half the return for the same seed issue and nearly the same labour.

This overall planting date effect is hardly influenced at all by level of soil fertility or a very wide range in plant population per unit area. Manuring and closer spacing are of no avail against the depression in yield caused by August planting. There is, however, some indication that manuring may influence the comparison of mid June with July plantings. This is being followed up.

The overall effect of varying the spacing from 9 inches to 27 inches apart along 3 foot ridges (thinning to 2 plants per stand in each case) is very slight. On average, 18 inch spacing (the standard) is about best. There is some indication of interaction of spacing and fertility level but this is more noticeable in plant size than fruiting. With early planting, manure enables wide-spaced plants to grow to very nearly three times the size of plants growing in one-third of the space, i.e., the amount of plant framework per acre is roughly the same at the two spacings. On poor unmanured soil or with late planting wide-spaced plants do not cover the ground, but they still show a higher yield per plant than close-spaced plants.

*Geering, Q. A. and Baillie, A. F. H. The Biology of Red Bollworm, *Diparopsis watersi* (Roths.), in Northern Nigeria. *Bull. ent. Res.*, *45*, 661.

Entomology

by

M. A. Choyce

Introduction.

Observations on the incidence of the major pests of cotton continued at Samaru, Daudawa, Kontagora, Gusau, and Yola throughout the season.

Insecticide trials were held at Samaru, Daudawa and Kontagora; no marked increases in yield were obtained in any of these experiments although at Samaru information was obtained concerning the effects of control of mirids.

Observations on the emergence of adults of red bollworm from long term pupae during 1952-53 have been completed.

Insect Pests.

Diparopsis watersi, Red Bollworm.*

The heaviest attacks of red bollworm occurred at Kontagora and Gombe; elsewhere the incidence was less and did not differ greatly from that recorded last year. Eggs were found throughout the season in most areas, and the maximum numbers of larvae were found during October and November.

Table 3 gives details of red bollworm activity during the season.

Table 3.

Diparopsis watersi. Egg and larval populations 1953-54. (Figures for 1952-53 in brackets).

Station	*Eggs per plant*	*Egg count peak/acre*	*Larval peak per acre*
Samaru (Botanist)	4·0 (4·8)	15,930 (18,290)	1,050 (1,480)
Samaru (Insecticide)	0·8 (1·5)	4,226 (3,570)	1,950 (1,970)
Daudawa (Insecticide)	2·8 (2·2)	4,472 (5,400)	3,170 (2,340)
Kontagora	12·9 (20·3)	17,500 (57,210)	6,180 (5,630)
Gusau	3·8 (3·5)	22,080 (7,260)	1,930 (2,830)
Yola	5·8 (6·0)	15,830 (15,240)	1,328 (4,180)
Gombe	3·4 (4·5)	6,130 (9,750)	11,110 (1,553)

Platyedra gossypiella, Pink Bollworm.

Pink bollworms were found in all areas, usually from late October onwards. At Samaru and Daudawa incidence was again low, and the largest populations were found at Yola and in Numan Division.

Table 4 shows the peak populations found in green and split bolls, together with the number of larvae per 1,000 split bolls from all pickings of the crop.

*E. O. Pearson, (1954) Emp. Cott. Gr. Rev., *31*, 171, has stated that the name *Diparopsis watersi* (Rothschild) takes precedence over *Diparopsis perditor* (Clements).

Table 4.

Platyedra gossypiella. Larval populations 1953-54.

(Figures for 1952-53 in brackets).

Station	*Peak population/acre in*		*No. of larvae per 100 split bolls*
	Green bolls	*Split bolls*	
Samaru (Botanist)	270 (830)	50 (300)	4 (20)
Samaru (Insecticide)	850	670	11
Daudawa (Insecticide)	Nil (810)	Nil (120)	Nil (5)
Kontagora	5,520 (1,110)	850 (120)	26 (5)
Gusau	2,250 (710)	510 (760)	23 (24)
Yola	3,900 (11,680)	1,510 (3,000)	52 (119)
Gombe	4,750 (7,990)	390 (4,610)	20 (168)
Numan Division.			
1. Shellen	13,190	—	89
2. Shellen	4,740	—	46
3. Guyuk	2,440	—	113
4. Bobbini	2,880	—	77
5. Gukuri	13,470	—	41

Other Bollworms.

Earias spp. Spiny and Egyptian bollworms were reported from all areas, with between 2,000 and 3,000 per acre occurring in green bolls during late October and November. The attack was heaviest at Gombe, where nearly 10,000 per acre were recorded in December. Additional damage to growing points was caused by these bollworms early in the season.

Argyroploce leucotreta (false codling moth) and *Heliothis armigera* (American bollworm) were uncommon in all areas.

Dysdercus superstitiosus, Cotton Stainer.

Stainers moved into the crop during September and generally remained in the crop until harvest. At Gombe and Kontagora over 10,000 per acre were recorded during October. Elsewhere peak populations of 2,000-3,000 per acre occurred, except in Numan Division where numbers were generally higher.

At Samaru few stainers were found after an early migration into the crop, and it is possible that breeding occurred before suitable food (split bolls) was available for nymphs.

Mirids and Leaf Tattering.

Mirids were again common at Samaru. On the Insecticide Trial the population of *Campylomma* was much less than last year. Migration into the crop reached a peak of only 1,600 swept per acre during early October. *Lygus,* though present in far fewer numbers than *Campylomma,* was more common than last year.

Tattering was again extremely variable. On the main farm at Samaru it was moderate, while parts of the extension fields suffered considerably. At Daudawa tattering was common, particularly at

Shemi where, in spite of excellent growth, some patches failed to set bolls early in the season. In other areas tattering was generally slight.

However, yield figures indicate that the cotton was able to compensate to a large extent for the early damage by further growth and fruiting. This is confirmed by the results of the Samaru Insecticide Trial.

Miscellaneous Pests.

The usual minor pests of cotton were noted.

Crop Loss.

Shedding.

Maximum loss from shedding occurred during October and November. Results of an examination of shed buds and bolls and split bolls are given in Table 5.

Table 5.

Percentage damage by bollworms amongst shed buds, shed and aborted bolls and ripe bolls, 1953-54.

(Figures for 1952-53 in brackets).

Station	*Shed buds*	*Shed and aborted bolls*	*Ripe bolls*
Samaru (Botanist)	43·5 (30·2)	39·5 (32·2)	56·5 (25·3)
Samaru (Insecticide)	26·6 (50·4)	15·2 (34·9)	27·0 (35·7)
Daudawa (Insecticide)	41·8 (44·9)	26·1 (20·7)	30·4 (38·3)
Kontagora	39·7 (59·2)	45·6 (63·9)	68·9 (92·3)
Gusau	57·5 (46·3)	42·2 (31·5)	37·5 (38·3)
Yola	56·5 (52·2)	17·0 (30·3)	37·4 (70·9)
Gombe	41·5 (39·1)	36·6 (29·6)	56·1 (47·9)

Heavy shedding occurred at Kontagora (35,000 buds and bolls per acre per week on 14th November) at Gombe (27,000 per acre per week on 31st October) and at Yola (25,000 per acre per week on 17th October).

Although bollworms were responsible for a high proportion of sheds in some areas, many fruiting points were lost because of stainers early in the season. At Samaru and Daudawa many fruiting points were lost owing to the feeding of mirids.

Nevertheless, even in the absence of these insect pests shedding by the cotton plant can be high, as illustrated by the results obtained on the Insecticide Trial at Samaru this year. On the control plots shedding of bolls reached a figure of over 50,000 per acre per week early in November, and only about 10% of these were damaged by bollworm.

Damage to Ripe Bolls.

An analysis of damage to split bolls is given in Table 4. The lowest proportion of clean seed cotton was produced at Yola, where losses due to causes other than bollworm were high. The results from Gombe, and from peasant farms in Numan Division, also show a low percentage of clean cotton.

Table 6.

Percentages of lock damage in non-shedding bolls, 1953-54.
(Figures for 1952-53 in brackets).

Station	*Clean*	*Boll-worm partial loss*	*Boll-worm total loss*	*Non-boll-worm partial loss*	*Non-boll-worm total loss*
Samaru (Botanist)	53·6 (75·8)	11·0	10·6	15·5	9·3
Samaru (Insecticide)	76·5 (68·4)	4·6	5·1	11·7	2·2
Daudawa (Insecticide)	76·2 (60·3)	11·9	8·4	1·8	1·8
Kontagora Standard	46·9 (18·1)	18·3	6·5	14·0	14·3
Gusau Standard	56·3 (61·2)	6·2	4·0	27·9	5·6
Gusau Peasant 1	62·0 (63·0)	7·0	7·1	18·0	5·9
Gusau Peasant 2	60·8 (—)	6·6	9·5	11·9	11·2
Yola Standard	24·0 (28·0)	5·7	8·5	38·8	23·0
Gombe Standard	41·4 (57·9)	20·0	5·7	23·3	9·6
Numan Division.					
Shellen 1	27·6	17·7	28·1	17·1	9·5
Shellen 2	39·2	13·3	24·0	14·0	9·5
Guyuk	33·8	14·7	19·6	20·0	11·9
Gukuri	59·5	10·0	12·5	13·1	4·9

Emergence of Red Bollworm from Long Term Pupae—1952-53.

In experiments conducted at Samaru during 1948 and 1949 and reported in the Corporation's Progress Reports for 1949-50, Geering showed that the emergence of moths from long-term pupae of *Diparopsis watersi* was bimodal, the first period extending from early June to early July, and the second during October. A similar bimodal emergence was recorded during 1950. Baillie and Geering (Progress Reports 1950-51) showed that a unimodal emergence occurred from long term pupae kept in the laboratory under equable temperature conditions and in the absence of waterlogging.

Similar experiments showing the emergence of moths from long term pupae during 1953 have now been completed and confirm the main points of the earlier work.

During the period October to December 1952 just over one thousand "rattlers" were set in pupation troughs under conditions simulating those found in the field. Development of diapause closely followed that given for 1950, and by the third week in November all pupae were long term.

Emergence from long term pupae in the troughs was again bimodal with a pronounced peak during the second week of October. In contrast to emergences recorded in 1949-50, however, there was a break of only about two weeks between the early and late emergence. The duration of this break is evidently very variable, and it would seem reasonable to suppose that in some seasons it is non-existent, emergence being continuous from June to October. If this is true, the behaviour of *D. watersi* in Northern Nigeria resembles more closely the activity of *D. castanea* in Nyasaland, where the emergence from diapause pupae extends from December to May, with a distinct drop in the wettest month, January.

Emergence of moths from pupae set under laboratory conditions, but with a high and fairly constant humidity, was earlier than that recorded from the troughs, and was more nearly unimodal.

A series of pupae removed from their earthen cells was also set in the laboratory; emergence from these was distinctly earlier than from "rattlers" set under similar conditions, and extended from January to August. If a similar result was achieved under field conditions, it would reinforce the view that early cultivation of land after growing cotton reduces the incidence of red bollworm during the next season. Geering and Baillie* have suggested that restriction of aeration during July and September delays emergence of the moth. Removal of the pupal cells may have a reverse effect by increasing aeration, so that early cultivation, in so far as it breaks up the earthen cells, would induce emergence before the main cotton crop became suitable for attack.

Under laboratory conditions one half of the pupae set produced moths, about 20% of the "rattlers" being parasitised by *Carcelia* sp. In the troughs, losses from parasitism and other, unknown, causes amounted to four-fifths of the "rattlers" set.

Further details of this work, including dates of emergence and figures for temperature and humidity, have been included in the Second Annual Report of the Northern Research Station, Department of Agriculture, Samaru.

Insecticide Trials.

(a) *Samaru.*

This experiment was arranged to distinguish between the effect of mirid and bollworm attack on the development and yield of cotton. It was a repetition on a larger scale of a similar experiment carried out during 1952-53, the results of which were inconclusive owing mainly to a wide variation in fertility within the experimental areas.

*Geering, Q. A. and Baillie, A. F. H. The Biology of Red Bollworm, *Diparopsis watersi* (Roths.), in Northern Nigeria. *Bull. ent. Res.*, *45*, 661.

The experiment was laid down on the main farm within an area of 4 acres of reasonably uniform cotton sown on 17th July and manured with 3 tons per acre FYM.

Eight replications of four treatments were arranged into two 4 × 4 Latin Squares, the treatments being: —

A—Early spraying to control mirids.
0·3% DDT at rate of 30 gallons per acre (0·9 lb. DDT per acre) applied six times at weekly intervals on 8th, 15th, 22nd, 29th September, 6th and 13th October.

B—Late spraying to control bollworms.
1·14% DDT at rate of 35 gallons per acre (4·0 lb. DDT per acre) applied 4 times at 2-week intervals on 27th October, 10th November, 24th November and 10th December.

C—Early and late spraying as for treatments A and B to control mirids and bollworms.

D—Untreated control.

Each plot consisted of 27 ridges of 18 yds. (approximately equal to 1/10 acre) and detailed observations were taken throughout the season on insect incidence and damage, and on crop development. Nine rows in each plot (162 sq. yds.) were preserved for yield estimation only, to prevent errors due to handling.

(1) *Mirid Population and Damage.*—The method of obtaining an estimate of the mirid population reported in the Progress Report for 1952-53 was again used. This consisted of sweeping 9 yds. of ridge 3 times for each observation, the total number of mirids caught being used to estimate the swept population per acre. Observations were made on the day before and the day after each application of the early spray, a different 9 yds. of ridge being used on each occasion.

The results do not show the true mirid population per acre owing to the difficulty of catching these small and active insects in the net. Neither are they strictly comparable with the results obtained last year, since different observers were used. Nevertheless they can be used to compare the populations within one experiment.

Campylomma was again the most common mirid present, but the swept population per acre was much lower than that recorded during the 1952-53 experiment. *Lygus,* on the other hand, though present in far fewer numbers than *Campylomma,* was definitely more common than last year. Small numbers of *Lygus* are known to do considerable damage to cotton, so that the damage produced by each is not necessarily in the same proportion as their respective populations.

The peak population of *Campylomma* (1,600 swept per acre) occurred during the first week in October, and that of *Lygus,* though not so clearly marked owing to the small numbers involved, was during early September. During the period of early spraying the mean

population of *Campylomma* on treatments A and C was reduced to 27% of that on the untreated plots.

A more precise method of determining mirid damage was used this year giving results less liable to subjective errors, and also showing the variation in damage that occurs throughout the season. Ten plants in each plot were examined at weekly intervals, the top 4 fully expanded leaves on the main stem being scored from 0 to 4 as determined by comparison with a photographic scale of damage. The maximum score per plant was 16, indicating very severe damage, and the lowest score was 0, indicating no damage.

Table 7 shows the total scores per treatment for seven weeks, with the scores for A and C expressed as a percentage of B and D.

TABLE 7.

SAMARU INSECTICIDE TRIAL, 1953-54. SCORES FOR MIRID DAMAGE.

Date	Treatments				*A+C as percentage of B+D*
	A	*B*	*C*	*D*	
22nd Sept.	404	538	425	583	74
29th Sept.	326	535	308	516	60
6th Oct.	278	430	224	506	54
13th Oct.	167	382	163	407	42
20th Oct.	134	335	129	396	36
27th Oct.	118	376	121	330	34
3rd Nov.	122	354	109	311	35
Totals	1549	2950	1479	3049	50

NOTE: Numbers represent total score on a scale of 0-4 on top four fully opened leaves of mainstem of 80 plants per treatment per week.

Mirid damage as recorded by this method showed a maximum when recordings began, decreasing as the season advanced on treated and untreated plots. The decrease in tattering on the untreated plots was much less than that recorded for the sprayed plots.

The variation in damage is not comparable directly with the mirid population at the time, because tattering is a result of feeding by the insects at the leaf-bud stage, and about a month elapses before the leaf is fully expanded. In addition, the rate of growth of the plant during the period of mirid attack, and hence the availability of flower and leaf buds for food, is probably different from the rate of increase in the mirid population. The results suggest that the food available per insect increased during September and October so that tattering became progressively less in spite of the higher insect population.

(2) *Bollworm Population and Damage.*—The most common bollworms attacking the crop were the red and spiny bollworms (*Diparopsis watersi* and *Earias* spp.). On the control plots two peaks of egg-laying by the red bollworm occurred, the first of 2,300 per acre during the second week in October and the second of 4,200 during the second week in November. Larval peaks of nearly 2,000 per acre occurred during

the weeks following maximum egg laying. No red bollworms were found in the crop after early December.

There were no marked differences in the numbers of bollworms collected from each treatment, presumably owing partly to the low level of infestation. The figures indicate that *Earias* was at least as damaging as *Diparopsis*.

Only small numbers of larvae of the false codling moth (*Argyroploce leucotreta*), pink bollworm (*Platyedra gossypiella*) and American bollworm (*Heliothis armigera*) were recorded.

Table 8 shows the percentage of shed buds, shed bolls, aborted bolls and ripe bolls damaged by bollworms. An analysis of lock damage in ripe bolls is given for each treatment in Table 9.

TABLE 8.

SAMARU INSECTICIDE TRIAL, 1953-54.

PERCENTAGE DAMAGE BY BOLLWORMS TO SHED BUDS, SHED BOLLS, ABORTED BOLLS AND RIPE BOLLS.

Treatment	*A*	*B*	*C*	*D*
Shed buds	24·8	30·3	23·1	26·6
Shed bolls	12·5	14·5	12·2	15·0
Aborted bolls	27·8	25·1	18·1	24·9
Ripe bolls	26·4	22·4	18·8	27·0

TABLE 9.

SAMARU INSECTICIDE TRIAL, 1953-54.

PERCENTAGE LOCK DAMAGE IN RIPE BOLLS.

Treatment	*A*	*B*	*C*	*D*
Clean locks	76·1	80·8	81·3	76·5
BW partial loss	4·6	3·8	3·5	4·6
BW total loss	5·3	3·5	3·6	5·1
Non-BW partial loss	12·9	9·6	10·2	11·7
Non-BW total loss	1·1	2·3	1·3	2·2

(3) *Flower Counts.*—Flower counts were taken on all plots, and showed that during the period of early spraying, more flowers were produced on sprayed plots than on unsprayed plots.

Treatments A and C produced 173,000 flowers per acre during the period from 13th September to 24th October, compared with a total of 150,000 on treatments B and D.

(4) *Yields.*—Table 10 gives the total yield for each treatment, there being no significant differences between them.

Five pickings were made, on 7th, 15th and 22nd December and on 4th and 26th January. The percentage of total yield taken at each picking is shown in Table 11.

Early spraying resulted in an early maturation of the crop, whereas late spraying has given a more even yield at each picking. The timing of the crop subjected to early and late spraying was similar to that of the untreated crop.

TABLE 10.

SAMARU INSECTICIDE TRIAL, 1953-54.

YIELDS IN LB. SEED COTTON PER ACRE.

Treatment.	*Yields.*	*Percentage of Control.*
B	695	100
A	694	113
C	763	110
D	785	100

S.E. 39

Coeff. of Variation: 14·9%

TABLE 11.

SAMARU INSECTICIDE TRIAL, 1953-54.

PERCENTAGE OF TOTAL YIELD TAKEN AT EACH PICKING.

Date of Harvest	*Treatments*			
	A	*B*	*C*	*D*
7th December	41·2	26·8	34·5	33·5
15th December	29·4	25·5	27·9	27·2
22nd December	17·3	23·4	20·6	19·9
4th January	10·3	21·5	15·2	16·7
26th January	1·8	2·7	1·8	2·8

(5) *Conclusion.*—It is concluded that control of mirids, with a subsequent reduction in visible leaf damage, is possible by a series of spray treatments during September and October. Adequate control can be achieved by weekly application of 1 lb. DDT per acre during the build-up of the mirid population. Owing to the continued migration of mirids to cotton during this period, frequent applications of insecticide are necessary, but these could be reduced if a more persistent insecticide was used.

Under the conditions of this experiment, control of mirids did not result in any increase in yield, but caused the crop to mature earlier. When subjected to a moderate mirid attack the cotton plant, which in any case normally produces more bolls than it can mature, is able to compensate for earlier loss of fruiting points by further growth and fruiting.

No significant increase in yield resulted from late spraying against bollworms, partly owing to the comparatively small numbers attacking the crop.

(b) *Daudawa.*

The trial at Daudawa was designed to compare the effect on yield and pest incidence of insecticide applied to cotton as a dust, as a low volume spray, and as a high volume spray.

The treatments were as follows:—

A—4 lb. DDT per acre applied as a cotton dust containing 10% DDT, and 3% gamma BHC.

B—4 lb. DDT per acre applied as a high volume spray at rate of 48 gallons per acre.

C—4 lb. DDT per acre applied as low volume spray at rate of 16 gallons per acre.

D—Control.

There were six replications of each treatment on plots of 1/4 acre, with adequate discards, and applications of all treatments were made on 22nd October, 12th November and 3rd December. The trial was situated on Daudawa Main Farm.

As at Samaru, the level of bollworm attack was very low and less than two per cent. of the green bolls collected throughout the season contained living red or spiny bollworms. A bollworm index is given for each treatment in Table 12, assuming a figure of 100 for the control plots.

TABLE 12.

DAUDAWA INSECTICIDE TRIAL, 1953-54.

EFFECT OF INSECTICIDE ON BOLLWORM POPULATION.

Treatment:	A	B	C	D
Diparopsis Index:	71	63	79	100
Earias Index:	86	59	74	100
Yield in lb. s/c. p.a.:	357	399	385	371

The final yields do not show any significant difference between treatments.

Cotton dust containing 10% DDT and 3% gamma BHC was also applied to an area of 2 acres of cotton showing excellent growth near the main trial. 30 lb. of dust per acre was applied, on 22nd October and 12th November, a third application being prevented by a steady harmattan. The yield of this area was 390 lb. seed cotton per acre, compared with 415 lb. per acre from an untreated area of similar growth adjacent to the dusted cotton.

(c) *Kontagora.*

A small area of cotton at Kontagora was dusted with insecticide containing 5% DDT, 3% gamma BHC and 40% sulphur at a rate of 30 lb. per acre, on 14th November, 21st November, 28th November and 2nd December. The treated plots yielded 215 lb. seed cotton per acre, compared with 202 lb. from control plots.

The experiment was carried out on a local farm on cotton planted on 15th August. Pest incidence was low and seed cotton obtained from the area of the trial was all grade 1. The result cannot, therefore, be regarded as representative of what would have occurred elsewhere in Kontagora, where insect damage was much higher, particularly on cotton planted earlier in the season.

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